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DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150786

SOLAR HEATING AND COOLING SYSTEMS DESIGN AND DEVELOPMENT (Quarterly Report)

Prepared from documents furnished by

Honeywell - Energy Resource Center
2600 Ridgway Parkway
Minneapolis, Minnesota 55413

Under Contract NAS8-32093 with

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy

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Solar Energy

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This work was done under the technical management of Al Krupnick, George C. Marshall Space Flight Center, Alabama.

16. ABSTRACT

Honeywell was awarded Contract NAS8-32093 by the George C. Marshall Space Flight Center (MSFC) effective 9 July 1976.

The program calls for the development and delivery of eight (was 12) prototype solar heating and cooling systems for installation and operational test. Two (was 6) heating and six heating and cooling units will be delivered for single-family residences (SFR), multiple-family residences (MFR) and commercial applications.

Lennox Industries, Marshalltown, Iowa, and Barber-Nichols Engineering Company, Arvada, Colorado, are supporting Honeywell in subcontractor roles.

This document describes the progress of the program during the eighth program quarter, 1 April 1978 to 30 June 1978.

17. KEY WORDS	18. DISTRIBUTION STATEMENT UC-59c
	Unclassified-Unlimited William A. Brooksbank, Jr. WILLIAM A. BROOKSBANK, JR. Mgr, Solar Heating and Cooling Project Office

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TABLE OF CONTENTS

LIST OF FIGURES

SECTION 1
COSTS

This section has been deleted.

SECTION 2
SCHEDULES

Schedules for each deliverable hardware system are shown in Figures 2-1 through 2-8. Current status schedules for systems that have sites selected are depicted in Figures 2-1 through 2-4, 2-6 and 2-7. The schedules for the two unidentified sites, Figures 2-5 and 2-8 that were dependent on site selection by 1 August 1977 continue to be in a day-for-day slip. Future reports will continue to reflect this slippage on applicable schedules.

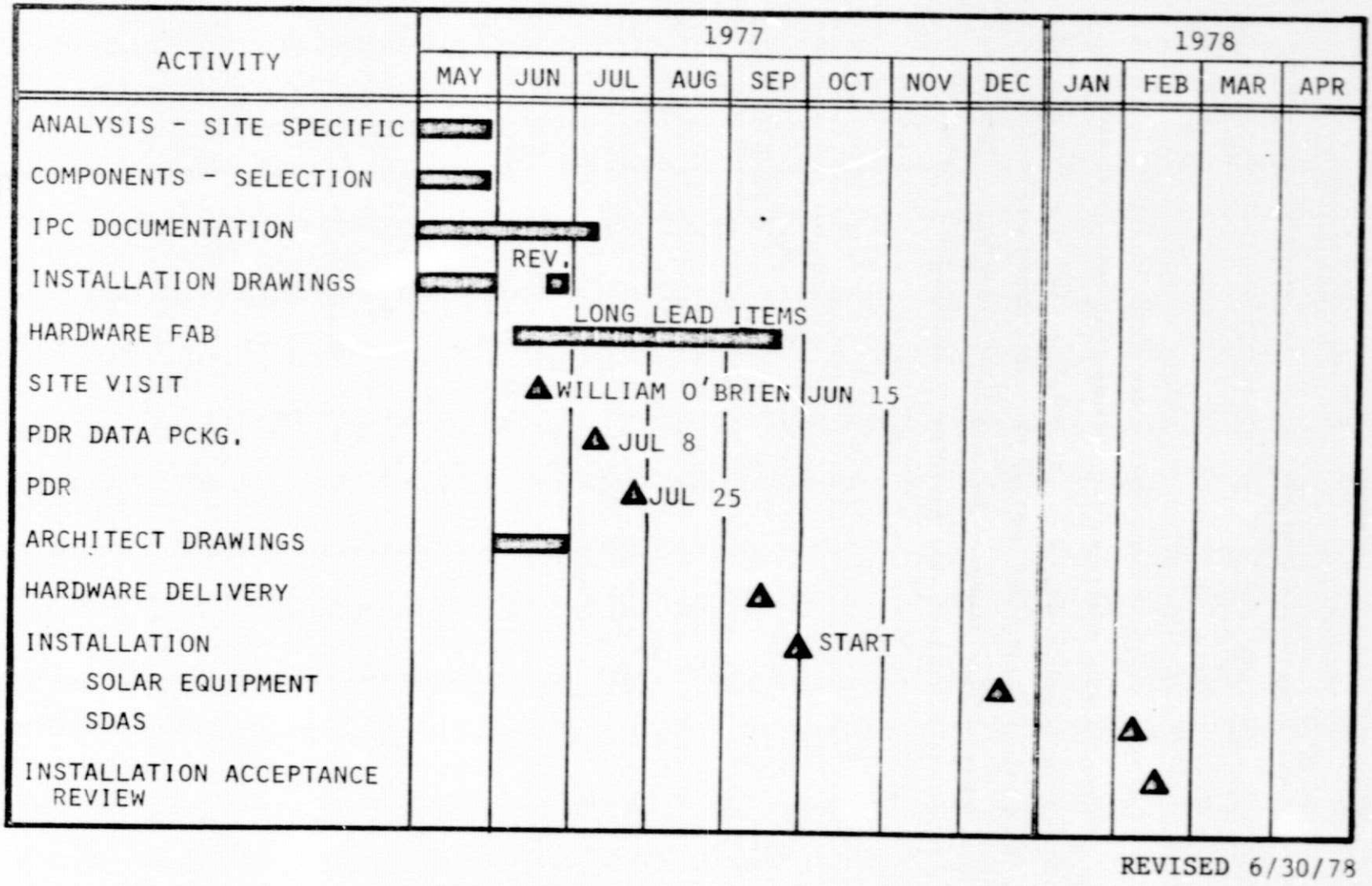

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Figure 2-1. Single-Family Residence (Heating Only) Stillwater, Minnesota (OTS #40)

78 3/4 1

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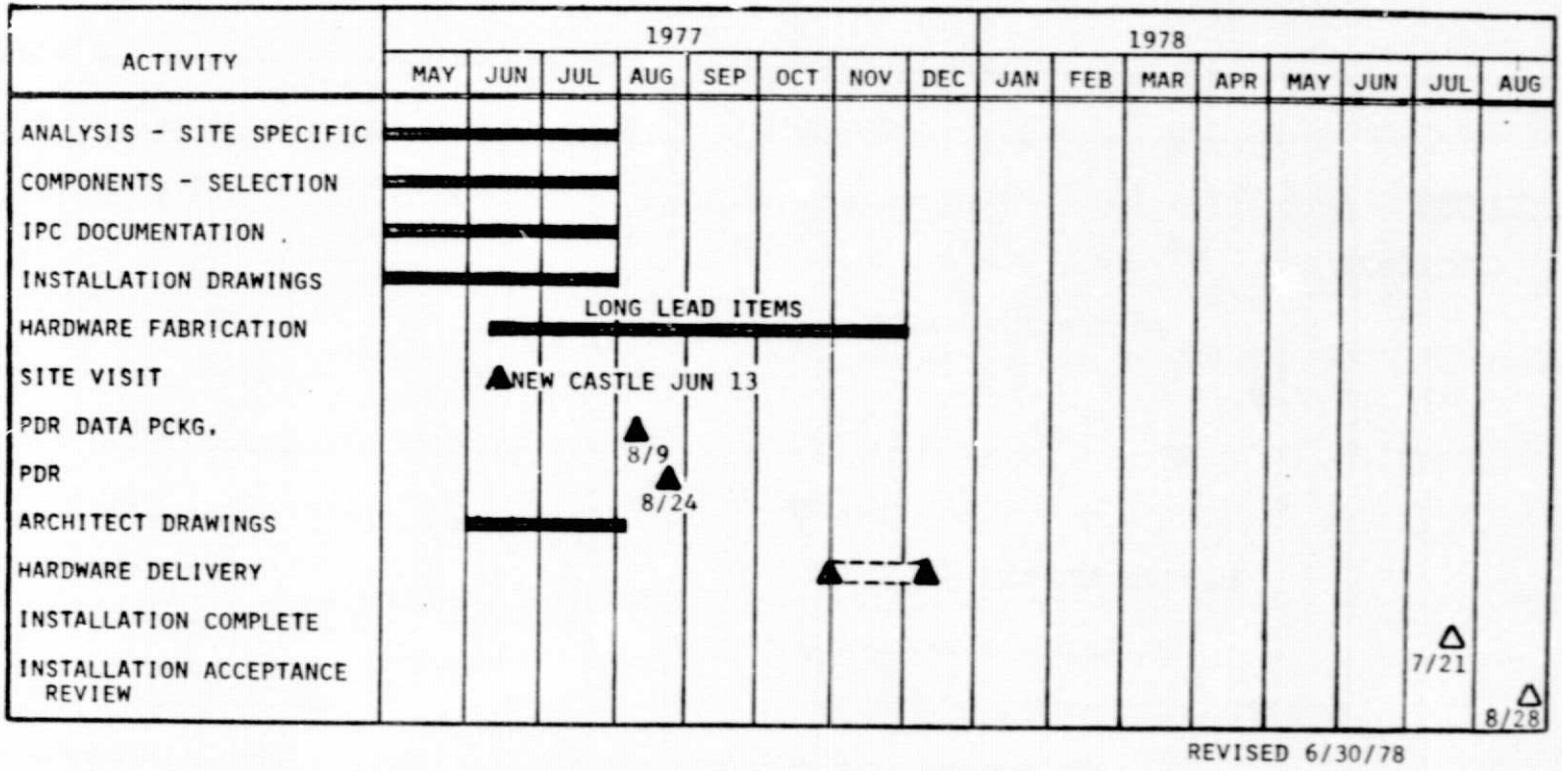

Figure 2-2. Single-Family Residence (Heating Only) New Castle, Pennsylvania (OTS #39)

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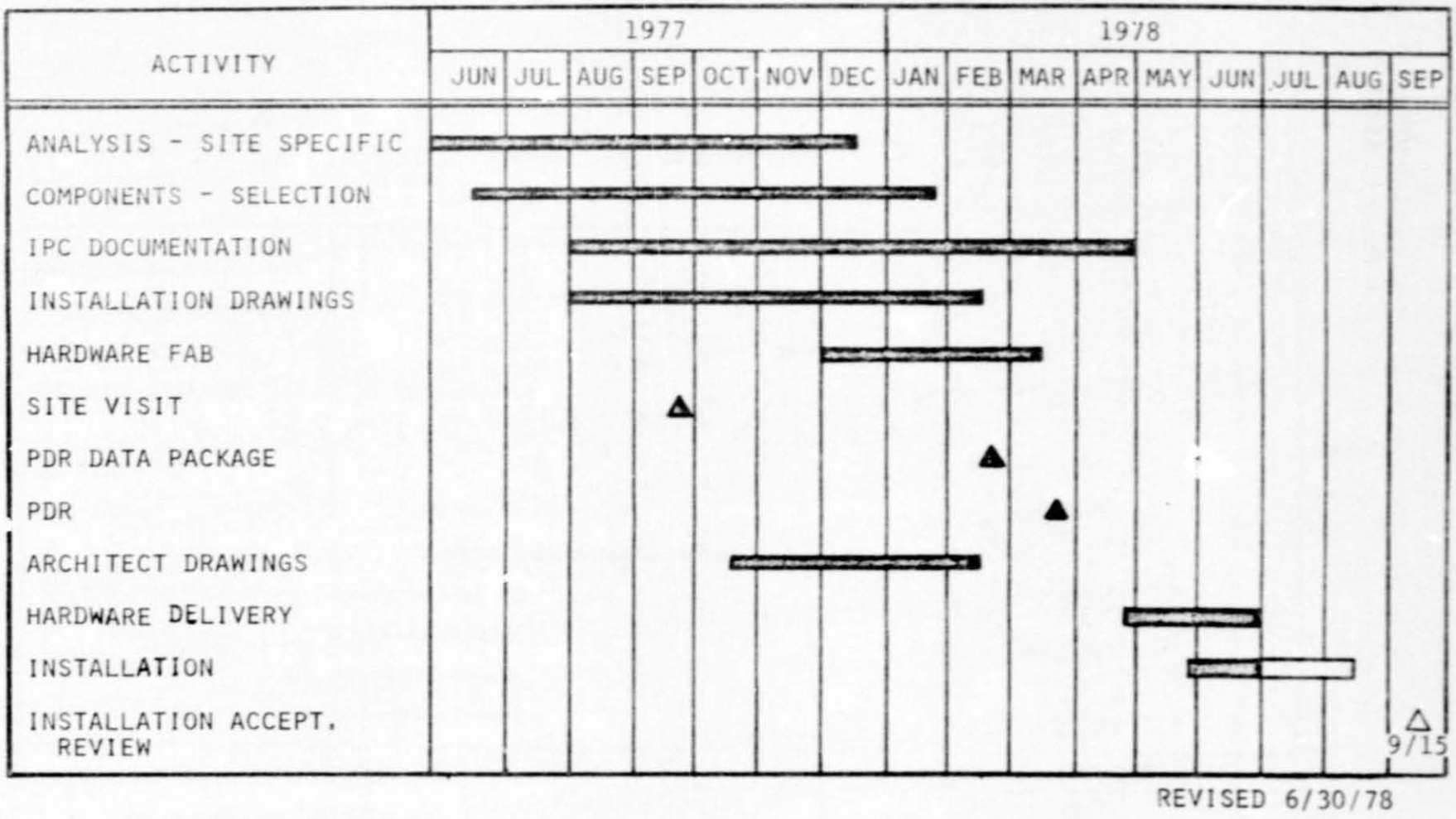

Figure 2-3. Kansas University Multiple-Family Residence (OTS #43)

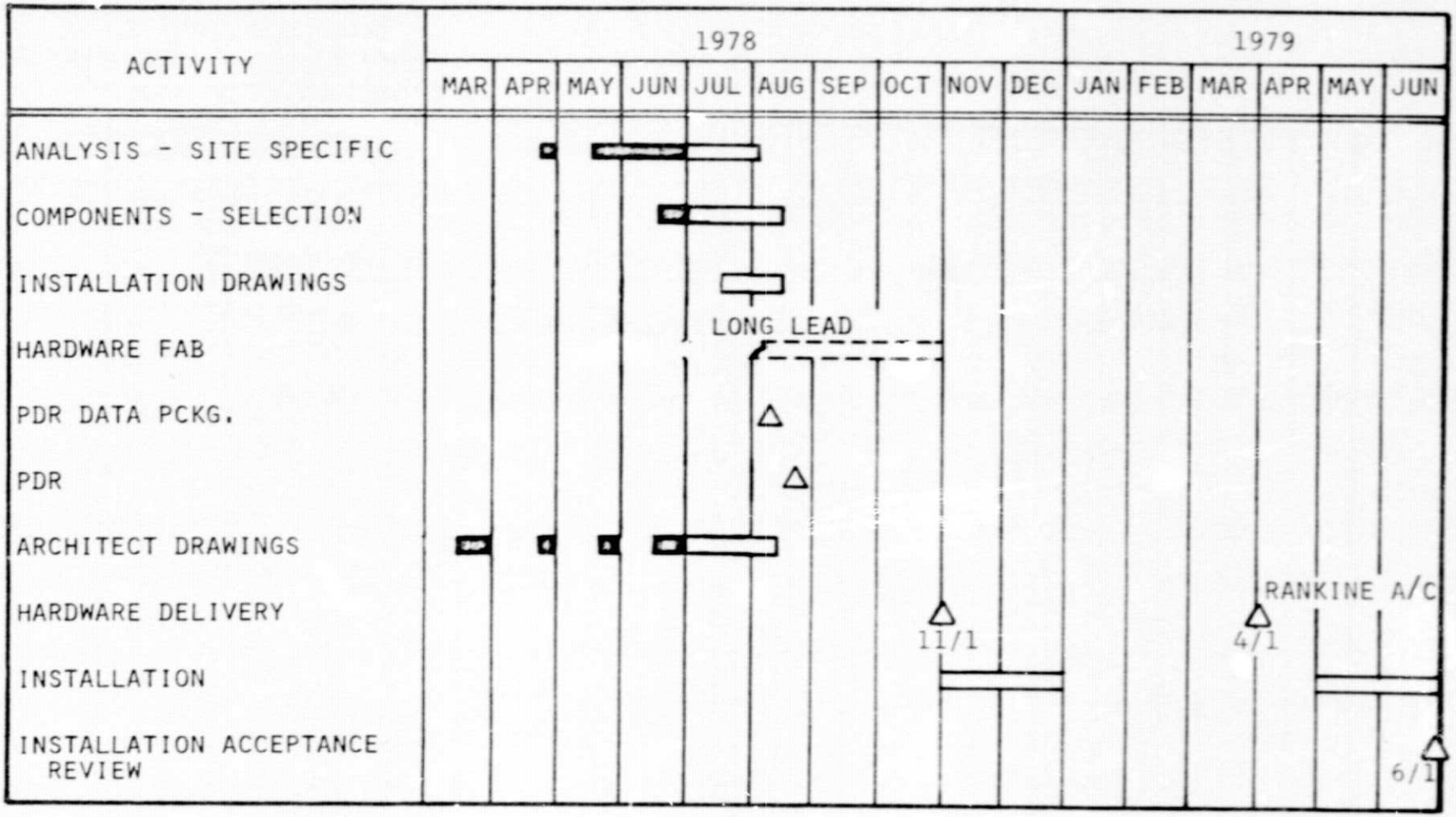

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Figure 2-4. Single-Family Residence Heating and Cooling Site -- Sacramento, CA (OTS #41)

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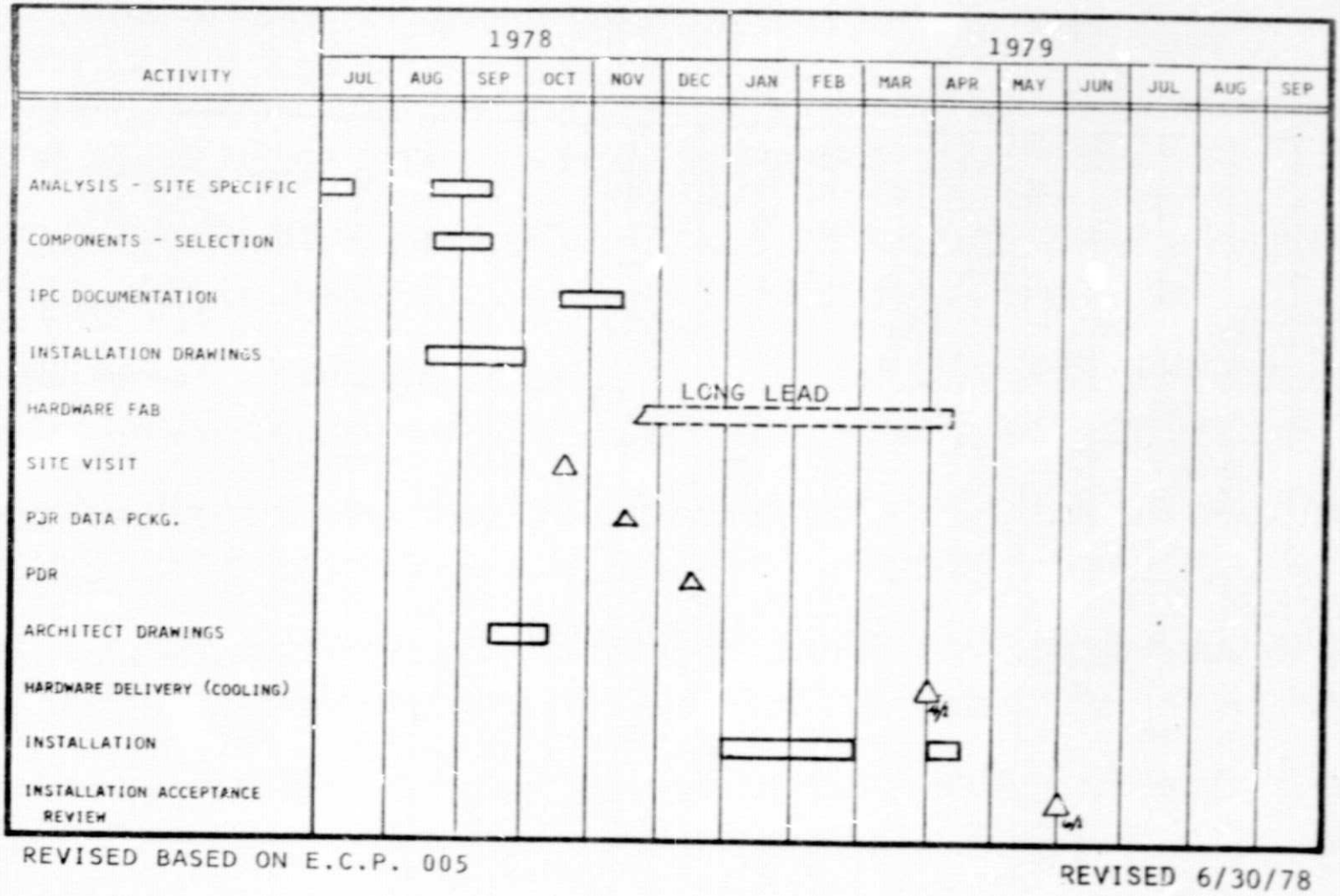

Figure 2-5. Single-Family Residence Heating and Cooling Site, TVA (OTS #42)

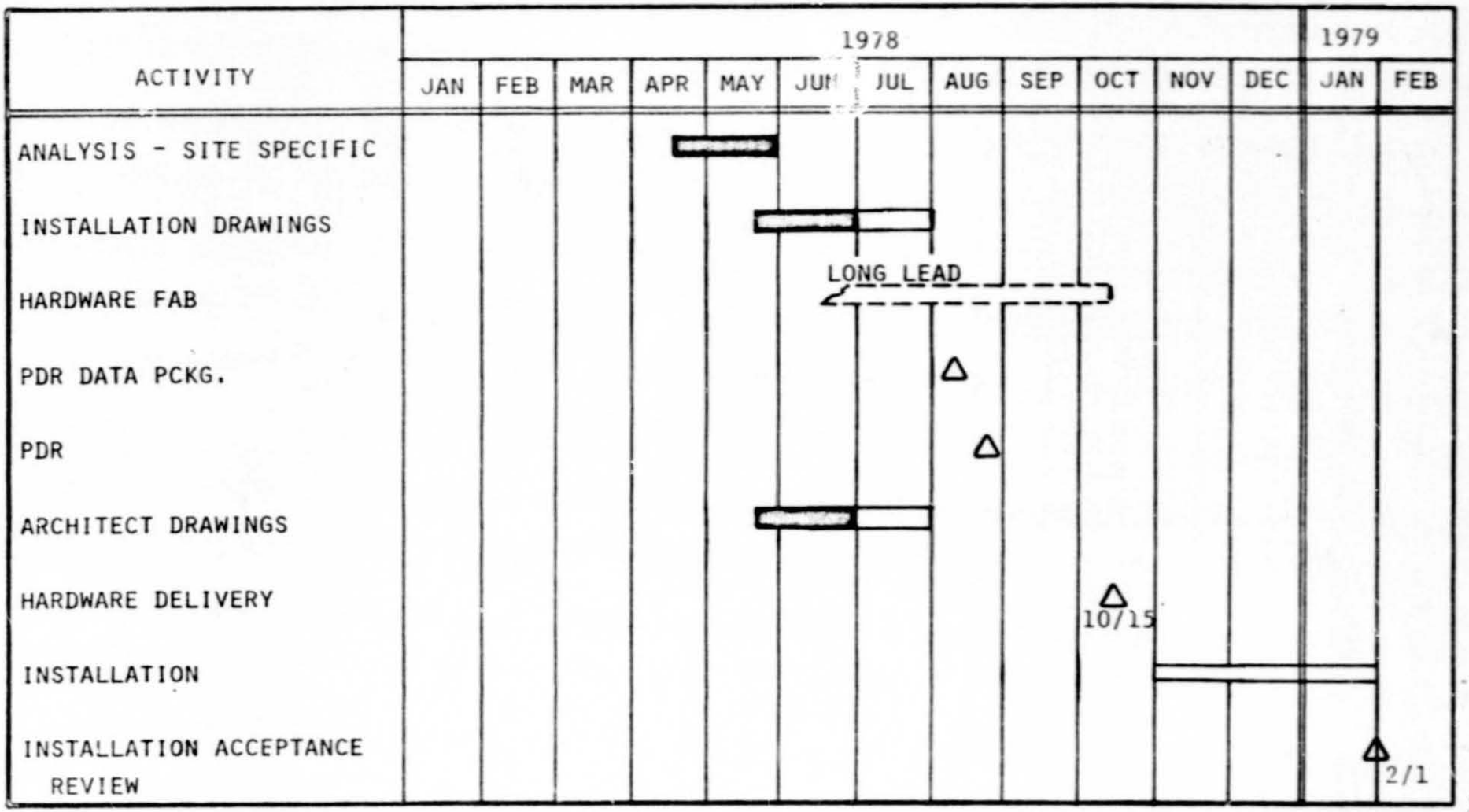

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Figure 2-6. Commercial Heating and Cooling (Ocmulgee) (OTS #44)

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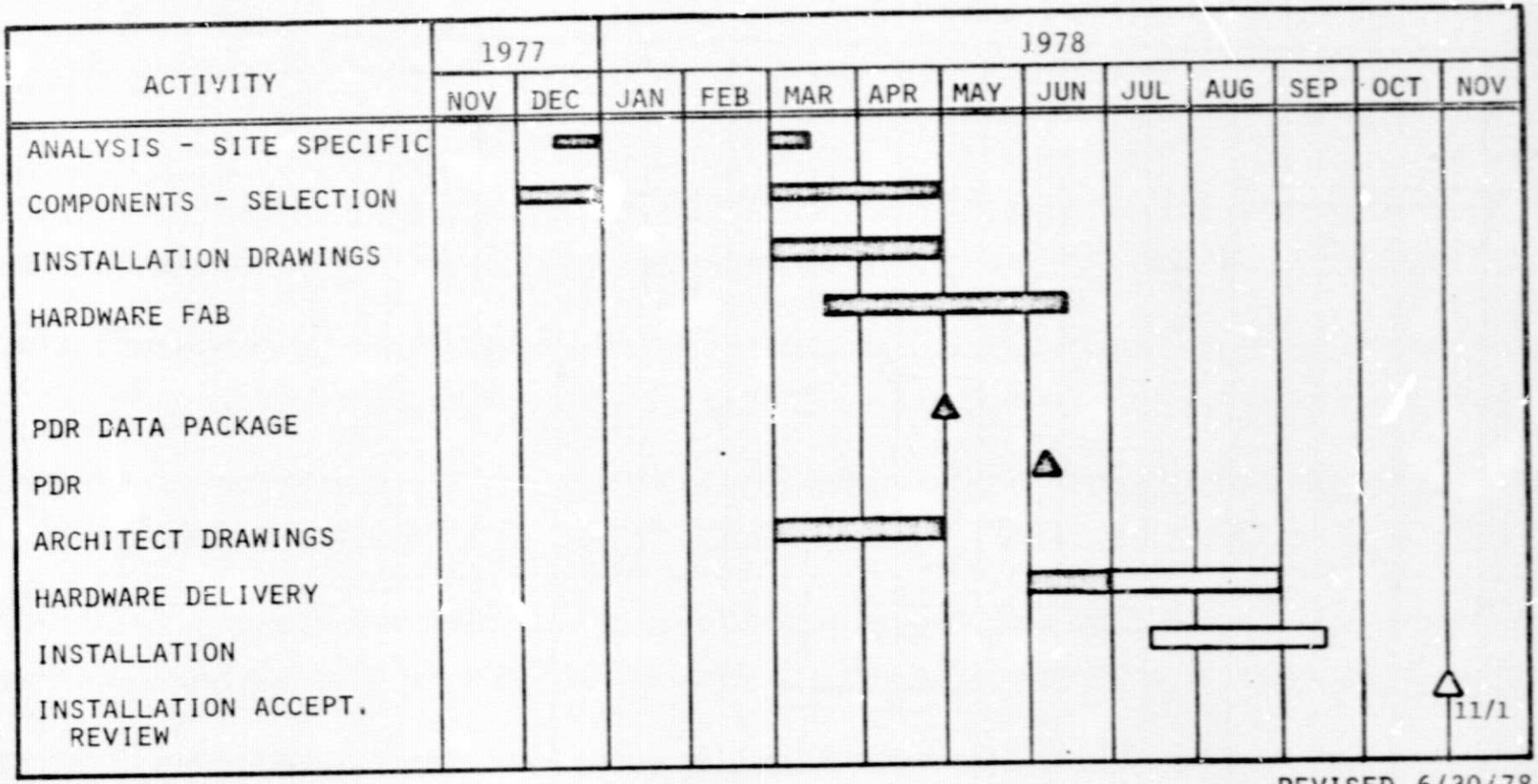

Figure 2-7. Commercial Heating and Cooling $\begin{bmatrix}\text{50 Ton}\\ \text{Lennox}\end{bmatrix}$ (OTS #46)

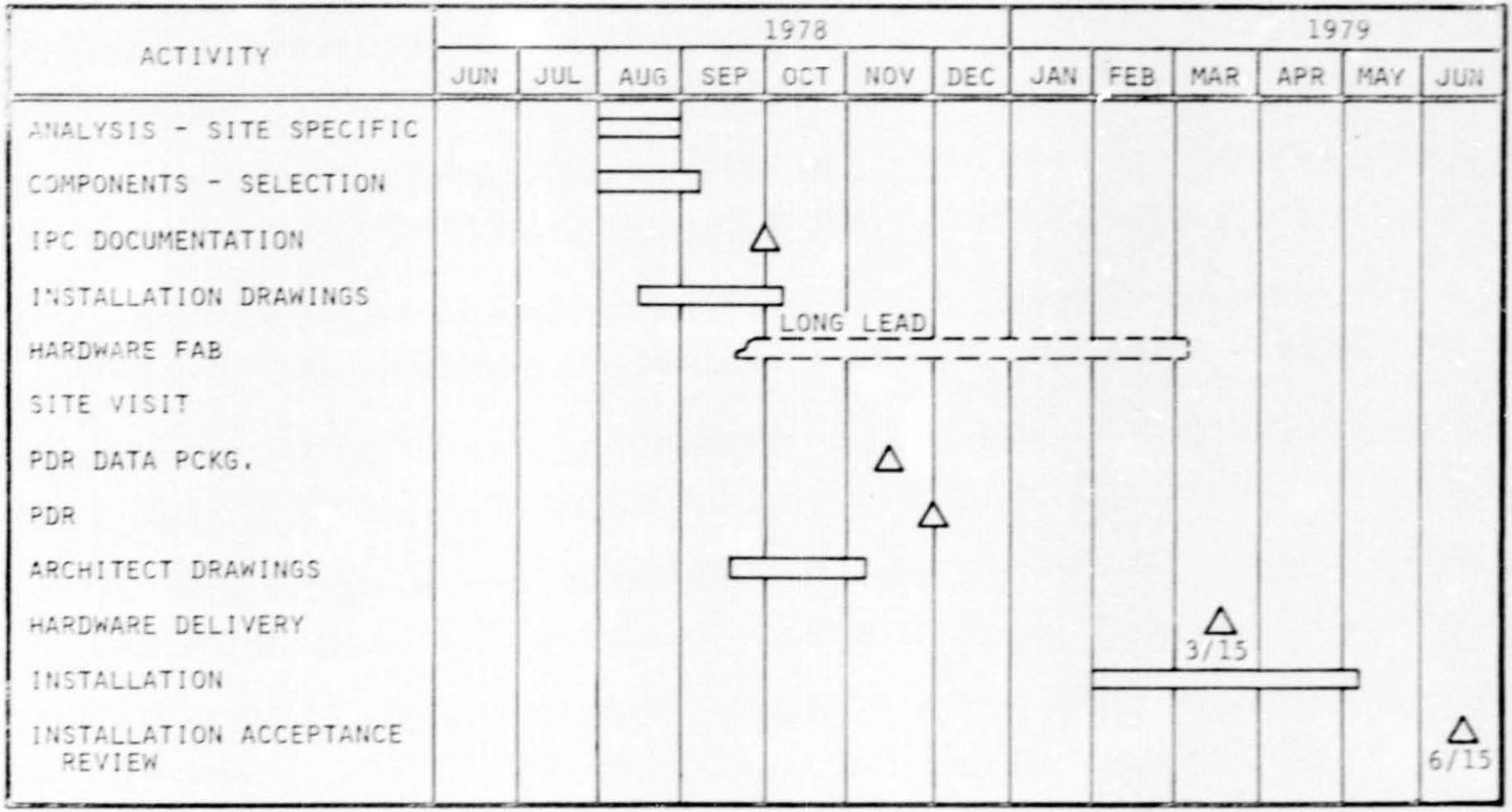

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Figure 2-8. Commercial Heating and Cooling $\left(\begin{matrix}75\ \text{Ton}\\ \text{Unidentified}\end{matrix}\right)$ (OTS #45)

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SECTION 3
TECHNICAL STATUS

WILLIAM O'BRIEN - SFR HEATING ONLY

The Certificate of Occupancy for the William O'Brien site has been received from Washington County, Minnesota. It states that all requirements of the Uniform Building Code and the various local ordinances regulating building construction for domestic use have been met. Prior to receipt of this certificate, the following tasks have been completed.

- Additional cellulose insulation was added to the top of the storage tank to maintain a cool environment temperature in the equipment room and to reduce heat transfer to the living quarters above.

- The ambient air temperature sensor (T001) was moved away from the collector field to the northeast corner of the garage roof. No heat given off by the collector field is sensed at this location.

- The pyranometer (I001) was moved from the east end of the collector field to the south side of the upper house roof. No early morning shading from trees is possible at this location.

- The air temperature sensor (T601) has been moved from the side of the furnace return air plenum to the back of the furnace near the solar water coil.

- The collector supply and return pipe in the sleeve through the south block wall of the equipment room was insulated, and the remaining space in the sleeves has been calked.

- The exposed portion of the collector return line between the return header and building penetration has been weatherproofed.

A summertime cover for the 5 x 3 collector array is being investigated. Since only solar DHW preheating occurs during the summertime, such a cover would reduce both storage tank temperature and time spent in the purge mode. The transport fluid would still pass through the 9 x 2 and 5 x 3 arrays, but a lower temperature mixed flow would pass to the storage heat exchanger. As a result, the system would spend more time in an "idle energy transfer" state. The collector plate sensor on the 9 x 2 array would initiate collector fluid circulation. However, the mixed-fluid temperature in the return line would take longer to reach the "purge" state. Also, it would take longer to reach the "charge storage" state once the storage tank has been charged to a sufficiently high temperature. The benefits are as follows:

- Less time spent in the "charge storage mode" and, therefore, lower pumping power expenditure.

- Less time spent in the "purge mode" and, therefore, lower power expenditure since the purge fan is off.

- Lower summertime storage tank temperature and, therefore, a cooler equipment room. At design condition of 3 gpm DHW flow, a 175^{o}F storage tank is sufficient to preheat the DHW to approximately 140^{o}F.

NEW CASTLE, PA - SFR HEATING ONLY

Construction at the site is nearly complete. Final SDAS wiring and miscellaneous items are yet to be completed. System startup and control checkout were completed in mid-June. All work should be completed by mid-July to provide for an Installation Acceptance Review in early August.

KANSAS UNIVERSITY - MFR HEATING AND COOLING

The site was visited on 28 and 29 June. The following items were noted:

- All piping has been properly installed in the building, including SDAS components.
- Furnaces have been removed from the apartments.
- Contractor A poured the cement for the cooling complex on 29 June.
- The Rankine chiller was delivered to the site.
- Tank insulation did not meet specification. This condition will be corrected by applying an additional coat of insulation and by painting it green.

Contractor A is two weeks behind schedule causing contractor B to vacate the job while waiting for site preparation. However, contractor B still intends to complete his work by 31 July. He would have to be installing collectors by 10 July to accomplish this.

CARROLLTON, TX - COMMERCIAL HEATING AND COOLING

Although the basic system design is complete, some architectural modifications have been made so the detail control subsystem design is continuing. Some pipe lines in the mechanical building and adjacent solar equipment complex

have been rerouted. Provisions have been incorporated for thermal expansion of the heating/cooling supply and return lines between the mechanical building and the plant.

Some additions and deletions were made in the SDAS instrumentation. All instrumentation for the DHW subsystem was deleted since it is completely independent of the solar system that supplies heating and cooling to the plant. Flow meters and temperature sensors have been added to the condensing water return lines for both Rankine engines and chillers.

SACRAMENTO, CA - SFR HEATING AND COOLING

The SFR heating and cooling system schematic is finalized. The simulations conducted for this 34-collector array indicate acceptable solar contribution if collectors are mounted flush on the eight-degree sloping roof. The decision was made to roof mount the collectors since performance is minimally affected, installation costs are reduced, and aesthetics are enhanced.

The furnace/heat coil/direct expansion coil configuration has been determined, as well as the sizing of headers and piping. A H/C Energy Transport Module configuration has evolved and is ready for an internal design review. The storage tank is sized at 1,000 gallons. The Mechanical Room, R/CA/C and purge layout agreed upon by Honeywell and the site architect remains unchanged. Detailed system design continues, and controls and SDAS design will begin next month. No major problems are anticipated; work progresses on schedule.

OCMULGEE NATIONAL MONUMENT, GEORGIA - LIGHT COMMERCIAL HEATING AND COOLING

Detailed system design work continues with preparation of construction drawings and bidding documents. Coordination with the A/E firm representing the NPS will result in a single combined bid package for the Visitor Center project.

The 90 percent package will be ready for the NFS on 8 August; the remainder will be ready by 28 August.

RESIDENTIAL COOLING SUBSYSTEM

Lennox and Barber-Nichols continue to work the detailed design of the components for the three-ton unit. Honeywell has conducted several technical and cost coordination meetings to assure design continuity and control expenditures.

The compressor has been selected and meets the recent COP goals presented at the PDR.

The regeneration is designed and in fabrication at the Fort Worth Lennox facility.

Evaporative condenser initial development tests are complete, and final sizing has been determined. Fabrication will be complete by mid-August for total subsystem development testing at Marshalltown, Iowa.

Boiler/demister design continues through the final packaging phase. One configuration has been determined. The outer shell design will be complete in early August.

Gearbox testing continues in an effort to define the final gear and lubrication configuration.

COMMERCIAL AND MULTI-FAMILY SUBSYSTEMS - 25 TON RANKINE CHILLER

The development on the first 25-ton unit was completed. A complete series of off-design data was run, and a performance map was drawn up from the data. The design point data was better than expected. This unit was shipped to Lennox at Carrollton, Texas. The second unit was tested and shipped to Kansas Univ-

ersity at Lawrence, Kansas. The third unit is ready for the acceptance inspection. The fourth through sixth units are in assembly. Problems continue with off-the-shelf components. Chillers leaked requiring changes and repair. The balance of the chillers were checked, and leaks were repaired.

The operation and maintenance manual is in the final stages of preparation.

SECTION 4
DATA SUBMISSIONS

A current Data Submissions Control Ledger is presented in Figure 4-1.

LEGEND: P - PLANNED SUBMISSION DATE
A - ACTUAL SUBMISSION DATE
M - MULTI SUBMISSIONS

PAGE 1 OF 1
REV. 21 DATE 7/10/78

CONTRACT DESCRIPTION: Solar Heating and Cooling | CUSTOMER: Geo. C. Marshall Space Flight Center | CONTRACT NUMBER: NAS8-32091

ITEM SEC. NUMBER	ITEM DESCRIPTION	FIRST SUBMISSION DUE	FREQ.	SUBMISSION DATES: JUL 77 P	JUL 77 A	AUG 77 P	AUG 77 A	SEP 77 P	SEP 77 A	OCT 77 P	OCT 77 A	NOV 77 P	NOV 77 A	DEC 77 P	DEC 77 A	JAN 78 P	JAN 78 A	FEB 78 P	FEB 78 A	MAR 78 P	MAR 78 A	APR 78 P	APR 78 A	MAY 78 P	MAY 78 A	JUN 78 P	JUN 78 A	JUL 78 P	JUL 78 A	REMARKS
1	DEVELOPMENT PLAN		A/R																											
2	VERIFICATION PLAN		A/R																											
4	QUALITY ASSURANCE PLAN		Once																											
5	SYSTEM PERFORMANCE SPECIFICATION		A/R																											
6	SOURCE & SPEC. CONTROL DRAWINGS		A/R									15								15										
6	CHANGE PROPOSAL & ASSOC. DATA		A/R																											
7	PRELIMINARY DESIGN REVIEW DATA		A/R																											
8	PROTOTYPE DESIGN REVIEW DATA (8)		A/R	6 (1)	7	9 (1)	10					10 (1)				1 (3)														
9	FIRST ARTICLE REVIEW DATA		A/R					21												22										
10	QUARTERLY REPORT		Qtrly	1	21					14	27					16	27					14	27					11		
11	MONTHLY STATUS REPORT		Month			12	16	15	16			14	22	14	20			14	27	14	21			12	6/6	14	26			
12	ACCEPTANCE DATA PACKAGE		A/R					21		12		15								22		12		15						
13	QUALIFICATION & ACCEPT. TEST. PROC.		Once																											
14	QUALIFICATION TEST AND/OR ANALYSIS REPORT		Once																											
15	SPECIAL HANDLING INSTALLATION AND MAINTENANCE - TOOL LIST		Once																											
16	SPARE PARTS LIST		Once	7	7	9						10 (1)				1 (5)														
17	INSTALLATION, OPERATION AND MAINTENANCE MANUAL		A/R	18				1 (1)		1 (1)				1 (1)				15 (5)												
18	HAZARD ANALYSIS		Once																											
19	DESIGN DATA BROCHURE		Once													30														
20	NON-CONFORMANCE REPORT		A/R																											
21	OPERATIONAL TEST REVIEW DATA		Once																											
22	LOGISTICS PLAN		Once																											
23	SYSTEM PERFORMANCE REPORT		Month															28		31		30		31		30		31		
24	SAFETY & HEALTH PLAN		A/R																											
25	NEW TECH. REPORTING PLAN		A/R																											
26	WORK BREAKDOWN STRUCTURE		A/R																											
27	FINANCIAL MANAGEMENT REPORT 533M		Month			19	19	19	21			18	20	16	20			17	17	17	17			19	19	16	16			
	533Q		Qtrly	18	19					14	17					13	13					14	14					18		
28	INSTALLATION ACCEPT. REVIEW(8)		A/R									15 (1)				17 (1)										15 (1)				Remaining five are scheduled in ~~Aug~~ Sep 78

Figure 4-1. Data Submissions Control Ledger

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